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(54) Process for the preparation of pure polylactide.

Verfahren zur Herstellung von reinem Polylactid.

Préparation et purification de polylactide.

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1.5 ppm, particularly at most 1 ppm; the catalyst anion is preferably ethyl-hexanoate, which is in the purified polylactide of the invention preferably present in a concentration of at most 0.5 % by weight of the polylactide.

The purified polylactide preferably contains apart from its lactide units further structural units e.g. such as described in the european Patent Application No 0270987, second passage on page 4, of which the glycolide unit is the preferred unit since, depending on its monomer ratio in the polymer chain, it can shorten the decomposition period of the polymer in the body and thus accelerate the drug compound release time. The glycolide unit is, as is known, the most frequently used additional unit in polylactides.

The monomer molar ratio's of the lactide/glycolide units in the polymers purified according to the invention are preferably 100-25/0-75, particularly 75-25/25-75, especially 60-40/40-60, more especially 55-45/45-55, e.g. 55-50/45-50.

It is known that the polymerisation reaction of monomers like lactide and glycolide is preferably carried out in the presence of a compound having one or more hydroxylgroups, which functions as a starter in building up a linear polymer chain. Known starters are e.g. lactic acid and glycolid acid. Other hydroxyl group containing compounds can also be used, e.g. alcohols. The starters are in fact used to control the chain length of the polylactides. A smaller amount of starting hydroxyl compound leads to longer chains than greater amounts. Excellent regulators are polyols, e.g. those described in the UK Patent Application GB 2.145.422A, of which mannitol and especially glucose are the most preferred.

By using this type of starting compounds relatively high molecular weight hard polylactide-co-glycolide materials can be obtained, which are very suitable as implants or microparticle materials, and have 2 or 3, preferably more than 3, e.g. 4 relatively short polylactide-co-glycolide chains and can hydrolyse in the body tissues within a relatively short drug release period of some weeks to e.g. 2 months or more, preferably within 4-6, e.g. 5 weeks. Although according to the invention the purified polylactides can have a linear structure, the preferred purified polylactides according to the invention are those having the structure described in the GB Patent 2.145.422 A, being esters of a polyol containing at least 3 hydroxyl groups, preferably those being an ester of a sugar or a sugar alcohol, especially an ester of glucose. They are star shaped, having a centre of e.g. the glucose rest and rays of linear polylactide chains.

After their preparation the star polymers are, more than the linear polymers, impurified by brown-coloured by-products, since the sugar or sugar alcohol, used for their preparation, is also be partially decomposed by the catalyst. The star polymers have monomer molar ratios of lactid/glycolide units which are preferably those, indicated above for the linear polymers.

The star polymers have preferably a mean molecule weight M_w of from 10000 to 200000, especially of from 25000 to 100000, particularly of from 35000 to 60000, e.g. about 50000 and preferably have a polydipersity M_w/M_n of from 1.7 to 3.0, especially from 2.0 to 2.5. Poly-lactide-co-glycolides of a linear structure, not being star polymers in a purified state according to the invention have preferably a mean molecular weight M_w of from 25000 to 100000 and have preferably a polydispersity M_w/M_n of from 1.2 to 2.

The molecular weight M_w is determined by gelpermeation chromatography, using polystyrene as a standard, e.g. Du-pont Ultrastyragel R 1000 or 500 Angstrom, in the column and e.g. tetrahydrofurane as the solvent.

The polylactides purified according to the invention can be obtained in a new process by contacting a solution of the impure polylactide with active charcoal and isolating the purified polylactide from the eluate. This process is also a part of the invention.

It is known from the UK Patent 1.467.970 and the EP 0181.621 A2 to treat polymers, produced in the presence of a catalyst with active charcoal.

According to the GB Patent 1.467.970, the polymer is a polyether, obtained from alkylene oxides, like ethylene oxide, propylene oxide or epichlorohydrin with an active hydrogen containing compound, e.g. glycerol, sorbitol or sucrose, in the presence of a basic catalyst. The polymer is purified with a mixture of active charcoal and magnesium silicate to remove crystals of polyalkylene glycols, e.g. polyethylene glycols, formed as by-products and which give the polymers a cloudy appearance and unsatisfactory viscosity and chemical properties. In a preferred method the polyethers are pretreated by means of a not further described other purification method to remove unreacted alkylene oxides and catalyst (page 2, lines 16-20). The basic catalyst thus could clearly not be removed by the charcoal - magnesium silicate mixture.

According to the EP 0181 621 A2 a solution of a polyalkylene ether in a cyclic ether or in a polyhydric alcohol solvent or the polyalkylene ether itself, e.g. polyoxytetramethylene glycol, prepared by the polymerisation of tetrahydrofuran under the influence of a heteropoly acid catalyst, e.g. 12-tungstophosphoric acid, is mixed with an organic hydrocarbon or halogenated hydrocarbon solvent. This solvent, which will contain the greatest part of the heteropoly acid, is separated from the other phase and the residue is contacted for further purification with a solid adsorbent, like charcoal, aluminium oxide or oxides, hydroxides or carbonates of e.g. Mg or Ca or with basic ion-exchange resins. According to Table 2 on page 23, the polymers contain 0.2 to 1.8 ppm of acidic metal impurification after purification with active charcoal.

This purification process is thus used to purify a polyether and to remove a very specific acidic catalyst type and it could not be foreseen, that active charcoal can be used for the removal of cations, like Sn. Also it could not be

foreseen, that such low impurity levels can be obtained as indicated.

The amounts of active charcoal used according to the purification process of the invention are generally from about 10 to 200 %, e.g. 70 to 150 % of the polymer weight. Any available charcoal can be used, e.g. as described in the Pharmacopoeia. A representative charcoal type is Norit of Clydesdate Co. Ltd., Glasgow/Scotland.

Typically powdered charcoal is used e.g. finely ground charcoal wherein at least 75 % passes through a 75 micrometer sieve. Suitable charcoals as used in the Example hereafter, are described in brochures, available from Norit, e.g. "Summary of methods for testing Norit activated carbons on specifications" by J. Visser.

The new purification process with charcoal is especially of interest for star polymers which have a dark brown colour. The colour effect may partly be caused by the polyol, e.g. the glucose, being instable to heat, especially in the presence of a catalyst and is more pronounced than a reference solution of colour strength B_1.

It is believed that the presence of small amounts of acidic groups in the active charcoal are responsible for the surprisingly efficient removal of the cations. If a solution of the catalyst in an organic solvent is treated with charcoal, the catalyst compound is decomposed and the tin is removed with the charcoal, which is filtered of, whereas the anionic part of the catalyst is quantitatively found back in the remaining solution.

For this reason the invention also provides a method for the purification of the polylactide by contacting a solution of the impure polymer with a matrix having on its surface acidic groups and isolating the purified polylactide from the eluate.

If desired a weakly acidic cationic exchanger with a carboxylic acid functionality may be used if it is of an appropriately small particle size. For example, one with a hydrogen ionic form, a density when wet of about 0.69 g/ml (apparent) and 1.25 g/ml (true), a shipping weight of 690 g/litre, an effective particle size of 0.33 to 0.50 mm, a moisture content of 43 to 53 per cent, a pH tolerated range of 5 to 14, a maximum operating temperature of 120°C, a total exchange capacity of 10 meq (dry) and 3.5 meq/ml (wet). An example is Amberlite IRC-50 Methacrylic aci DVB (available from Fluka, Switzerland) which is ground to have the particle size diameter reduced e.g. to below 1 mm or 100 microns.

The matrix for the purification, e.g. the charcoal, preferably has a suitable concentration of from 0.01 o 0.1 millimole of acidic groups per gram of matrix and is conveniently in the form of particles which may be finely divided. Typical particle diameters are e.g. from 1 micrometer to 1 mm, e.g. from 10 to 100 micrometers.

They have therefore a large surface area. For example active charcoal has a surface area of 1000 square metres for each ml of matrix substance.

The purification process of the invention is preferably related to a polylactide preparation using lactide and glycolide as monomers and metal cations, like Sn^{++} as a catalyst, since this polymerisation process gives a better yield and, if desired, a higher molecular weight than the preparation process using lactid acid and glycolic acid as starting compounds and the strong acid ion-exchange resin as a catalyst, described in the European Patent No. 0026599.

Starting with an impure polylactide-co-glycolide containing about 1800 ppm of Sn^{++}, the concentration of Sn^{++} can be lowered to about 200 ppm. A purification with charcoal can lower the Sn^{++} content, as already mentioned, to less than 1.5, e.g. less than 1 ppm.

The purification process of the invention is preferably carried out with a solution of an impure polylactide in acetone although other solvents are possible.

The process may be followed by another purification process, preferably the process of ultrafiltration, which reduces the content of low molecular compounds, e.g. of lactide and glycolide. Also in this process a polylactide solution in acetone can be used.

After the second purification process purified polylactides can be obtained, having a monomer content of at most 1 % by weight of polymer, preferable of at most 0.25 % of polymer, e.g. of at most 0.2 % of lactide and 0.05 % of glycolide, a water content of at most 1 %, an organic solvent, e.g. methylene chloride or acetone, content of at most 1 %, preferably of at most 0.5 % e.g. of at most 0.3 % and an ash content of at most 0.1 % by weight of polylactide. Their acid number is preferable at most 10. The thus purified polylactides are preferably parenterally used, e.g. as a matrix for drug compounds, especially such in implants or in microparticles form. These forms may be prepared in conventional manners, which have abundantly been described in the literature e.g. in the European Application No 58481, the UK Patent Application GB 2.145.422, the European Patent Application No 52510 the US Patents 4.652.441 and 4.711.782, the French Application No 2.491.351, the US Patent 3.773.919.

The forms are suitable for e.g. incorporating a hydrophilic drug like a peptide, e.g. a cyclopeptide and particularly a hormonally active peptide, like a somatostatin, especially octreotide, or an acid addition salt or a derivative thereof, or a lipophilic drug, like an ergot alkaloid, e.g. bromocriptine.

The pharmaceutical compositions are formed by working up the purified polylactide with the drug compound to form an implantate or a microparticle.

EXAMPLE 1:

a) Preparation of PLG-Glu

This is prepared as described in the above-mentioned UK Patent Application GB 2.145.422.

D,L-lactide and glycolide (60/40 % by weight) containing trace amounts of lactic and glycolic acid as impurities, are polymerised at 130 °C in the presence of 0.2 per cent (w/w) D (+) glucose and 0.6 per cent (w/w) of tin octanoate (product T9 from M & T Chemicals which is the tin (II) salt of 2-ethyl hexanoic acid; Lemon yellow liquid; Viscosity (20°) 1.2636; Refractive Index 1.4950; Tin content 27-29 %; 2-ethyl hexanoate content accroding to NaOH titration 69 per cent). The product is the polylactide-co-glycolide glucose ester (PLG-Glu) having a lactide/glycolide ratio of 60/40 g (basis) or 55/45 mole (basis). Mw = 50000. Lactide/glycolide content ca 3 % of weight. The colour is dark brown and is according to the used colour index more intensely coloured than a reference solution B_1. The tin content is 1800 ppm.

b) Treatment with active charcoal

130 g PLG-Glu is dissolved in 1950 ml acetone to give a clear dark brown solution. Within 5 minutes 130 g active charcoal is added. The mixture is stirred for 3 hours at room temperature and filtered. The material filtered off is washed with 1.5 litres of acetone. The filtrate is slightly yellow, of a colour index B_9. It is evaporated under a vacuum and the residue is dried at 70°C and finally under a vacuum of 1mm Hg. Mw = 50000; Lactide/glycolide content ca 3 %. Heavy metal content: less than 10 ppm.

Resultant analysis: Fe 3 ppm; Zn 1 ppm; Cu 1 ppm; Ni, Pb and Sn each under 1 ppm.

The filtered off charcoal contains practically all the tin and the filtrate practically all the 2-ethylhexanoic acid from the catalyst. (If the experiment is repeated with 50 per cent active charcoal by weight of polymer then the product contains 290 ppm Sn)

c) Ultrafiltration

The product from step b) (180g) is dissolved in 1.8 litres of acetone to give a bright yellow solution. The product is subjected to ultrafiltration using a laboratory pressure filtration apparatus, using acetone (ca. 4 x 1800 ml) as a solvent under a pressure of 5 bar having a membrane from DDS Type FS 81PP (exclusion limit 6000) diameter 14 cm, with a permeation rate of about 110 to 165 ml/hour. The permeation solution contains lactide/glycolide and lactic and glycolid acid and is coloured yellow. The residual solution in the pressure chamber (2215 ml of solution) is evaporated after a run of 46 hours. The product is taken up again in acetone, filtered and dried at 70 to 80°C in a vacuum. The product (148 g) contains 0.2 % by weight of lactide; 0.05 % by weight of glycolide. Acetone content 0.3 % by weight. No 2-ethyl hexanoic acid is detectable by gas chromatography (i.e. its content is less than 0.1 per cent). M_w = 50000 according to GPC.

Accordingly to the colour test laid down in the European Pharmacopoeia 2nd Edition, Section V.6.2 the polymer is "colourless". The product is not more intensely coloured than the reference solution B_9.

EXAMPLE 2:

4 kg of poly(D,L-lactide-co-glycolide) purified according to the method of Example 1 and having a Mw 55100, were dissolved in 53 kg of methylene chloride.

To the filtered solution 1 kg of bromocriptine-mesylate was added. The resulting suspension was intensively mixed by means of an Ultra-Turrax and spray dried. The generated microparticles were sieved, washed with 0.01 molar methane-sulfonic acid/sodium chloride solution and rinsed with isotonic saline. The microparticles were dried under vacuum at 40-45°C and sieved. The microparticles were filled in glass-vials under nitrogen and sterilized by gamma-irradiation (dose: 25 kGy).

The final product is an aseptically filled two chamber syringe (TCS) consisting of one compartment containing the microparticles and one compartment containing a vehicle for suspension of the microparticles.

Vehicle composition:

	mg/ml
Potassium-dihydrogenphosphate	3.603
Disodium-hydrogenphosphate (anhydrous)	5.68
Pluronic F68	2.0
Sodium-carboxymethylcellulose (Blanose 7LFD)	10.0
Benzylalcohol	10.0
Water for injections ad	1.0 ml
Nitrogen	q.s.

The TCS are suitable for e.g. i.m. administration, once every 4 weeks.

Results from clinical studies obtained with the TCS in postpartum women, patients with hyperprolactinemia/-microprolactinomas and patients with macroprolactinomas demonstrate a continuous release of active substance and a good systemic and local tolerability as well as good efficacy of single and multiple administrations of bromocriptine-microparticles.

EXAMPLE 3:

One g of poly (D,L,-lactide-co-glycolide)glucose, M_w 46000, (50/50) molar, (produced according to the process of GB 2.145.422, Polydispersity ca. 1.7, produced from 0.2 % of weight glucose and purified according to Example 1) was dissolved in 10 ml of methylene chloride with magnetic stirring followed by the addition of 75 mg of Octreotide dissolved in 0.133 ml of methanol. The mixture was intensively mixed e.g. by means of an Ultra-Turax for one minute at 20,000 rpm causing a suspension of very small crystals of Octreotide in the polymer solution. The suspension was sprayed by means of a high speed turbine (Niro Atomizer) and the small droplets dried in a stream of warm air generating microparticles. The microparticles were collected by a "zyklon" and dryed overnight at room temperature in a vacuum oven.

The microparticles were washed with 1/15 molar acetate buffer pH 4.0 during 5 minutes and dried again at room temperature in a vacuum oven. After 72 hours the microparticles were sieved (0.125 mm mesh size) to obtain the final product.

The microparticles were suspended in a vehicle and administered i.m. in 5mg/kg dose of Octreotide to white rabbits (chincillabastard) and s.c. in a 10mg/kg dose to male rats.

Blood samples were taken periodically, indicating plasma levels of 0.3 to 10.0 ng/ml (5 mg dose) in rabbits and 0.5 to 7.0 ng/ml in rats for 42 days as measured by Radioimmunoassay (RIA) analysis.

Claims

1. A method for obtaining a polylactide being an ester of a polyol containing at least 3 hydroxyl groups and being in a purified state, which meets the requirements of

   - the colour strengths of reference solutions B_2 - B_9 of the brown colour test of the European Pharmacopoeia, 2nd Edition (1980) part I, Section V, 6.2 and

   - containing one or more metals in cationic form, the metal ion(s) having a concentration of at most 10 ppm,

   by contacting a solution of the impure polylactide with a matrix having on its surface carboxylic groups and isolating the purified polylactide from the eluate.

2. A method according to claim 1, which includes contacting the solution of the impure polylactide with active charcoal.

3. A method according to claim 1, in which the isolation includes a further purification step, which is ultrafiltration.

4. A method according to any one of claims 1-3 in which the impure polylactide is dissolved in acetone.

5. A method according to any one of claims 1-4, for obtaining a polylactide having the colour strength of reference solutions B_4 -B_9.

6. A method according to any one of claims 1-5, for obtaining a polylactide, having the colour strength of reference solution B_9.

7. A method according to any one of claims 1-6, for obtaining a polylactide, in which the metal ion is Sn++.

8. A method according to any one of claims 1-7, for obtaining a polylactide, having a Sn++ concentration of at most 1.5 ppm.

9. A method according to any one of claims 1-8, for obtaining a polylactide, in which the salt anion is ethyl hexanoate.

10. A method according to claim 9, for obtaining a polylactide, having an ethyl hexanoate concentration of at most

0.5% by weight of the polylactide.

11. A method according to any one of claims 1-10, for obtaining a polylactide, having a

monomer	content of at most	1% by weight of the polylactide
water	"	" "
organic solvent	"	" "
ash	"	0.1 "
and having an acid number	" "	10.

12. A method according to any one of claims 1-11, for obtaining a polylactide, containing additionally glycolide units.

13. A method according to claim 12, for obtaining a polylactide, having lactide/glycolide molar ratio's of 100-25/0-75.

14. A method according to claim 13, for obtaining a polylactide, having molar ratio's of 75-25/25-75.

15. A method according to claim 14, for obtaining a polylactide, having molar ratio's of 60-40/40-60.

16. A method according to claim 1, for obtaining a polylactide, being an ester of a sugar or of a sugar alcohol.

17. A method according to claim 16, for obtaining a polylactide, being a glucose ester.

18. A method according to claim 16 or 17, for obtaining a polylactide, having a mean molecular weight M_w of from 10'000 to 200'000.

19. A method according to claim 16 or 17, for obtaining a polylactide having a polydispersity $^{Mw}/_{Mw}$ of from 1.7 to 3.0.

Patentansprüche

1. Verfahren zur Herstellung eines Polylactids, das ein Ester eines Polyols mit einem Gehalt von mindestens 3 Hydroxylgruppen ist und sich in gereinigtem Zustand befindet, welches die Vorschriften erfüllt, daß

   - die Farbstärken der Bezugs lösungen B_2 bis B_9 des braunen Farbtests der European Pharmacopoeia, 2. Auflage (1980), Teil I, Abschnitt V, 6.2 entsprechen und
   - eines oder mehrere Metalle in kationischer Form vorhanden sind und die Metallionen eine Konzentration von höchstens 10 ppm haben,

   durch Behandlung einer Lösung des unreinen Polylactids mit einer Matrix, die auf ihrer Oberfläche Carboxylgruppen aufweist, und Isolierung des gereinigten Polylactids aus dem Eluat.

2. Verfahren nach Anspruch 1, das eine Behandlung der Lösung des unreinen Polylactids mit Aktivkohle einschließt.

3. Verfahren nach Anspruch 1, bei dem die Isolierung eine weitere Reinigungsstufe einschließt, die eine Ultrafiltration ist.

4. Verfahren nach einem der Ansprüche 1 bis 3, bei dem das unreine Polylactid in Aceton gelöst wird.

5. Verfahren nach einem der Ansprüche 1 bis 4 zur Herstellung eines Polylactids, das eine den Bezugslösungen B_4 bis B_9 entsprechende Farbstärke hat.

6. Verfahren nach einem der Ansprüche 1 bis 5 zur Herstellung eines Polylactids, das eine der Bezugslösung B_9 entsprechende Farbstärke hat.

7. Verfahren nach einem der Ansprüche 1 bis 6 zur Herstellung eines Polylactids, bei welchem das Metallion Sn^{++} ist.

8. Verfahren nach einem der Ansprüche 1 bis 7 zur Herstellung eines Polylactids, das eine Konzentration an Sn^{++}

von höchstens 1,5 ppm hat.

9. Verfahren nach einem der Ansprüche 1 bis 8 zur Herstellung eines Polylactids, bei dem das Salzanion Ethylhexanoat ist.

10. Verfahren nach Anspruch 9 zur Herstellung eines Polylactids, bei dem die Konzentration an Ethylhexanoat höchstens 0,5 Gewichtsprozent des Polylactids beträgt.

11. Verfahren nach einem der Ansprüche 1 bis 10 zur Herstellung eines Polylactids, mit folgenden Daten:

Gehalt an Monomer	höchstens 1 Gew.-% des Polylactids
Gehalt an Wasser	höchstens 1 Gew.-% des Polylactids
Gehalt an organischem Lösemittel	höchstens 1 Gew.-% des Polylactids
Gehalt an Asche	höchstens 0,1 Gew.-% des Polylactids
und	
Säurezahl	höchstens 10.

12. Verfahren nach einem der Ansprüche 1 bis 11 zur Herstellung eines Polylactids, das zusätzlich Glycolid-Einheiten enthält.

13. Verfahren nach Anspruch 12 zur Herstellung eines Polylactids, das ein Molverhältnis von Lactid zu Glycolid von 100 bis 25 zu 0 bis 75 aufweist.

14. Verfahren nach Anspruch 13 zur Herstellung eines Polylactids, das ein Molverhältnis von Lactid zu Glycolid von 75 bis 25 zu 25 bis 75 aufweist.

15. Verfahren nach Anspruch 14 zur Herstellung eines Polylactids, das ein Molverhältnis von Lactid zu Glycolid von 60 bis 40 zu 40 bis 60 aufweist.

16. Verfahren nach Anspruch 1 zur Herstellung eines Polylactids, das ein Ester eines Zuckers oder eines Zuckeralkohols ist.

17. Verfahren nach Anspruch 16 zur Herstellung eines Polylactids, das ein Glucoseester ist.

18. Verfahren nach Anspruch 16 oder 17 zur Herstellung eines Polylactids, das ein gewichtsmittleres Molekulargewicht M_w von 10.000 bis 200.000 hat.

19. Verfahren nach Anspruch 16 oder 17 zur Herstellung eines Polylactids, das eine Polydispersität M_w/M_w von 1,7 bis 3,0 hat.

Revendications

1. Un procédé d'obtention d'un polylactide qui est un ester d'un polyol contenant au moins 3 groupes hydroxy, est sous forme purifiée et satisfait aux exigences suivantes:

   - les intensités de couleur des solutions de référence B_2 - B_9 selon l'essai de couleur marron de la Pharmacopée Européenne, 2ème édition (1980) 1ère partie, section V, 6.2 et

   - contient un ou plusieurs métaux sous forme cationique, le ou les ions métallique(s) ayant une concentration de 10 ppm au maximum,

   par mise en contact d'une solution du polylactide impur avec une matière de base comportant des groupes carboxy à sa surface, et isolement du polylactide purifié à partir de l'éluat.

2. Un procédé selon la revendication 1 qui comprend la mise en contact de la solution du polylactide impur avec du charbon actif.

3. Un procédé selon la revendication 1, dans lequel l'isolement comprend une étape supplémentaire de purification qui est l'utltrafiltration.

4. Un procédé selon l'une quelconque des revendications 1 à 3, dans lequel le polylactide impur est dissous dans l'acétone.

5. Un procédé selon l'une quelconque des revendications 1 à 4, pour l'obtention d'un polylactide ayant l'intensité de couleur des solutions de référence B_4 - B_9.

6. Un procédé selon l'une quelconque des revendications 1 à 5, pour l'obtention d'un polylactide ayant l'intensité de couleur de la solution de référence B_9.

7. Un procédé selon l'une quelconque des revendications 1 à 6, pour l'obtention d'un polylactide dans lequel l'ion métallique est Sn^{++}.

8. Un procédé selon l'une quelconque des revendications 1 à 7, pour l'obtention d'un polylactide ayant une concentration en Sn^{++} de 1,5 ppm maximum.

9. Un procédé selon l'une quelconque des revendications 1 à 8, pour l'obtention d'un polylactide dans lequel l'anion du sel est l'éthylhexanoate.

10. Un procédé selon la revendication 9, pour l'obtention d'un polylactide ayant une concentration en éthylhexanoate d'au plus 0,5% en poids du polylactide.

11. Un procédé selon l'une quelconque des revendications 1 à 10, pour l'obtention d'un polylactide ayant

une teneur en monomères	d'au plus 1% en poids du polylactide,
une teneur en eau	d'au plus 1% en poids du polylactide,
une teneur en solvant organique	d'au plus 1% en poids du polylactide,
une teneur en cendres	d'au plus 0,1% en poids du polylactide,
et un indice d'acide de	10 au maximum.

12. Un procédé selon l'une quelconque des revendications 1 à 11, pour l'obtention d'un polylactide contenant en outre des motifs glycolide.

13. Un procédé selon la revendication 12, pour l'obtention d'un polylactide ayant des rapports molaires lactide/glycolide de 100-25/0-75.

14. Un procédé selon la revendication 13, pour l'obtention d'un polylactide ayant des rapports molaires de 75-25/25-75.

15. Un procédé selon la revendication 14, pour l'obtention d'un polylactide ayant des rapports molaires de 60-40/40-60.

16. Un procédé selon la revendication 1, pour l'obtention d'un polylactide qui est un ester d'un sucre ou d'un alcool de sucre.

17. Un procédé selon la revendication 16, pour l'obtention d'un polylactide qui est un ester de glucose.

18. Un procédé selon la revendication 16 ou 17, pour l'obtention d'un polylactide ayant une masse moléculaire moyenne M_p de 10 000 à 200 000.

19. Un procédé selon la revendication 16 ou 17, pour l'obtention d'un polylactide ayant une polydispersité M_p/M_n de 1,7 à 3,0.